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Potamogeton ×tosaensis (Potamogetonaceae), A New Hybrid from Kochi Prefecture (Shikoku, Japan)

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Potamogeton ×tosaensis Kadono, Horii & Yamanouchi (Potamogetonaceae) is described here as a new hybrid. Although similar to *P. octandrus*, it is morphologically distinguishable in several traits. Most conspicuous of these are the connate stipules and fusiform turion bearing one acerose leaf. The plants were found only in and around Kochi City, Shikoku. *Potamogeton octandrus* and *P. pusillus* are the putative parents.

Key words: connate stipules, hybrid, Kochi Prefecture, *Potamogeton*, *P. octandrus, P. pusillus*, *P. ×tosaensis*

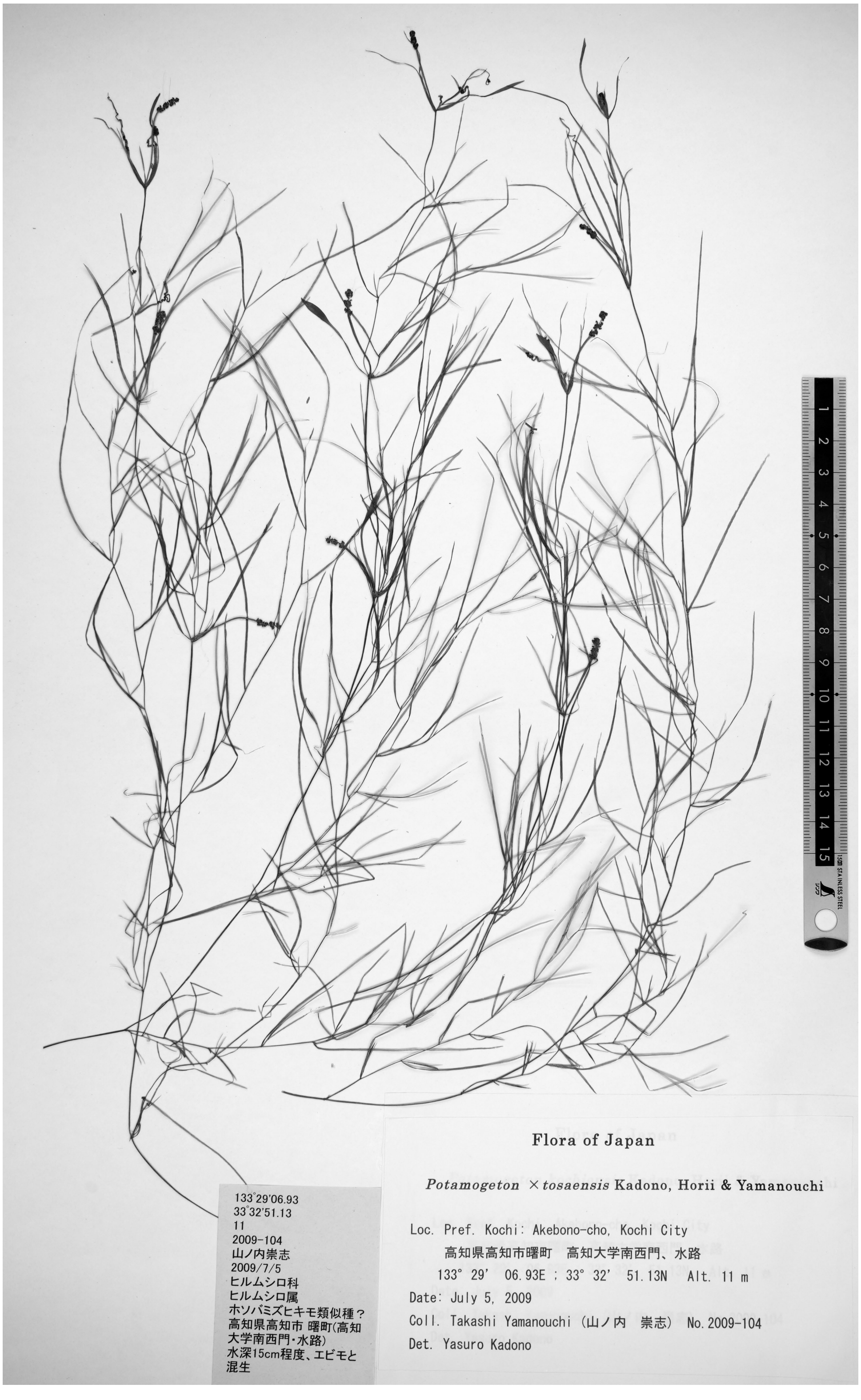
Potamogeton L. (Potamogetonaceae) is a cosmopolitan genus comprising approximately 70–90 species and 50 hybrids (Cook 1996, Wiegleb & Kaplan 1998). To identify the species of *Potamogeton* is difficult because phenotypic variation in response to prevailing environmental conditions is common and hybridization is frequent (Hagströem 1916, Wiegleb 1988, Kaplan 2002). Since Fernald (1932) and Ogden (1943), the genus has been traditionally split into broad-leaved and linear-leaved species. A molecular phylogenetic study by Lindqvist *et al*. (2006) showed that these two groups belonged to different lineages as two major clades in *Potamogeton*.

Within these two groups the taxonomy of linear-leaved species has especially been confused because of reduced morphology, phenotypic plasticity and frequent hybridization (Fernald 1932, Haynes 1974, Kadono 1994). During our field survey of Japanese linear-leaved *Potamogeton*, we collected specimens from several populations in Kochi Prefecture, Shikoku, Japan, that were largely similar to *P. octandrus* Poir. but clearly differed in a few characters. Based on our comparative study of specimens of similar taxa and an extensive literature survey, we recognize and describe them as a new hybrid.

Potamogeton ×tosaensis Kadono & Horii ex Kadono, Horii & Yamanouchi, **hybr. nov.** —Figs. 1–3
Potamogeton tosaensis Kadono & Horii in Kadono, Field Guide Aquat. Pl. Japan: 118 (2014), nom. nud.

Similar to *Potamogeton octandrus*, but different from it in having narrower floating leaves (when present), either having or lacking floating leaves when flowering, having basally connate and tubular stipules and a fusiform turion.

Typus. JAPAN, Kochi Pref.: Akebono-cho, Kochi City, July 5, 2009, *T. Yamanouchi 2009-104* (holo-KYO; iso-OSA, MBK).



133°29'06.93
33°32'51.13
11
2009-104
山ノ内崇志
2009/7/5
ヒルムシロ科
ヒルムシロ属
ホソバミズヒキモ類似種？
高知県高知市 曙町(高知大学南西門・水路)
水深15cm程度、エビモと混生

Flora of Japan

Potamogeton ×*tosaensis* Kadono, Horii & Yamanouchi

Loc. Pref. Kochi: Akebono-cho, Kochi City
高知県高知市曙町　高知大学南西門、水路
133° 29’ 06.93E ; 33° 32’ 51.13N Alt. 11 m
Date: July 5, 2009
Coll. Takashi Yamanouchi (山ノ内　崇志) No. 2009-104
Det. Yasuro Kadono

FIG.1. Holotype of *Potamogeton ×tosaensis* Kadono, Horii & Yamanouchi (*T. Yamanouchi 2009-104*, KYO).

Herbs, perennial, aquatic, submerged or occasionally with a few floating leaves. Rhizomes inconspicuous, creeping, terete. Stems slender, slightly compressed, branched. Stipules thinly membranous, 6–12 mm long, 1/4 to 1/2 of the basal portions connate and tubular. Leaves dimorphic; submerged leaves alternate, sessile, linear, 3–6 (–8) cm long, 0.8–1.2 mm wide, 3-nerved, apex acute, floating leaves petiolate; petiole 1.5–3 cm long; blade lanceolate to oblong, 1.2–2.0 cm long, 2–4 mm wide; leaves intermediate in morphology between submerged and floating forms sometimes occur. Turions axillary, fusiform, 1.0–1.5 cm long, with 1 (–2) acerose leaf, present from July onward. Flowering occuring in both submerged and floating-leaved forms; peduncle 1.2–2.0 cm long, spikes 7–12 mm long. Flowers usually six per spike, pairs of flowers arranged in three whorled inflorescences; pollens abortive; carpels 4. Fruit not seen. Stele "one-bundled type" (*sensu* Ogden 1943) in stems with subepidermal vascular bundles.

Japanese name. Tsutsu-mizuhikimo (Kadono 2014).

Other specimens examined. JAPAN. Shikoku. Kochi Pref.: Kitayama, Haruno-cho, Kochi C., *T. Yamanouchi 2009-77*; Maeda River, Wakakusa-minami-machi, Kochi C., *T. Yamanouchi 2008-10*; Toichi River, Ike, Kochi C., *T. Yamanouchi 2009-123*; Gohda River, Asakura-kou, Kochi C., *T. Yamanouchi 2009-127*; Kinoshita River, Yakushi, Kochi C., *T. Yamanouchi 2008-8*; Moriyama, Haruno-cho, Kochi C., *K. Horii* & *Y. Kadono 46*; Shimonoda, Nangoku C., *T. Yamanouchi 2009-67*; Kaira, Nangoku C., *K. Horii* & *Y. Kadono* 33; Yoshida, Okatoyo-machi, Nangoku C., *K. Horii* & *Y. Kadono 35*; Nishiura, Tosa C., *T. Yamanouchi 2009-32*; Uji River, Okuna, Ino T., *T. Yamanouchi 2009-142*.

All of these specimens are in the Herbarium of Kobe University and will be distributed to KYO, OSA and MKB.

Notes on the characteristics suggesting hybrid origin of Potamogeton ×tosaensis. The submerged or floating-leaved plants initially appeared to be *Potamogeton octandrus*, however, the submerged leaves were slightly wider than those of *P. octandrus* (0.3–1.0 mm wide). The floating leaves were narrower and fewer (1–3 when present; up to 8 or more floating leaves, 4–10 mm wide in *P. octandrus*). The most conspicuous characters were the tubular stipules, which were connate basally (Fig. 2C, D). The flowers were usually in whorls of 3 [vs. 4(or 5) in *P. octandrus*, and 2 in *P. pusillus* L. (Syn. *P. panormitanus* Biv.)] (Fig. 3A, B, C). The perianth (sepaloid connectives) opened at anthesis. The anthers were swollen and dehiscent, but the pollen was abortive (Fig. 3D). Fusiform turions with one (rarely two) acerose leaf resembled those of *P. pusillus* (Fig. 3E, F).

This combination of traits and the presence of sterile flowers indicate that our plants were hybrids between a small floating-leaved species and a species with connate stipules. As candidates for the former, *Potamogeton octandrus* and *P. cristatus* Regel et Maack were considered. *Potamogeton cristatus* is a very rare species and never occurs in flowing waters as far as we can determine. Furthermore, the short flowering period is in June and the plants remain vegetative or disappear in summer (Kadono 2014). It has not been recorded from Kochi Prefecture (Kochi Prefecture & Makino Memorial Foundation of Kochi Prefecture 2009). In contrast, *P. octandrus* is common in flowing water and flowers continuously from June to September. Thus we suspected that *P. octandrus* is one of the most probable parents. Another putative parent is *P. pusillus*, because it is the only fertile linear-leaved species with connate stipules. The validity of our hypothesis on the putative parents will be evaluated by future DNA analysis.

The distribution of *Potamogeton* ×*tosaensis* is concentrated in and around Kochi City, where it was common in flowing water of rivers and streams. According to Kadono (1994) and the Kochi Prefecture and Makino Memorial Foundation of Kochi Prefecture (2009), both *P. octandrus* and *P. pusillus* are present in the prefecture, which is congruent with our suggestion that these two species are the putative parents, although we have not found a locality where both species co-occur. It is also subject to future study whether hybridization occurred once or multiple times.

Yamanouchi & Ishikawa (2011) observed

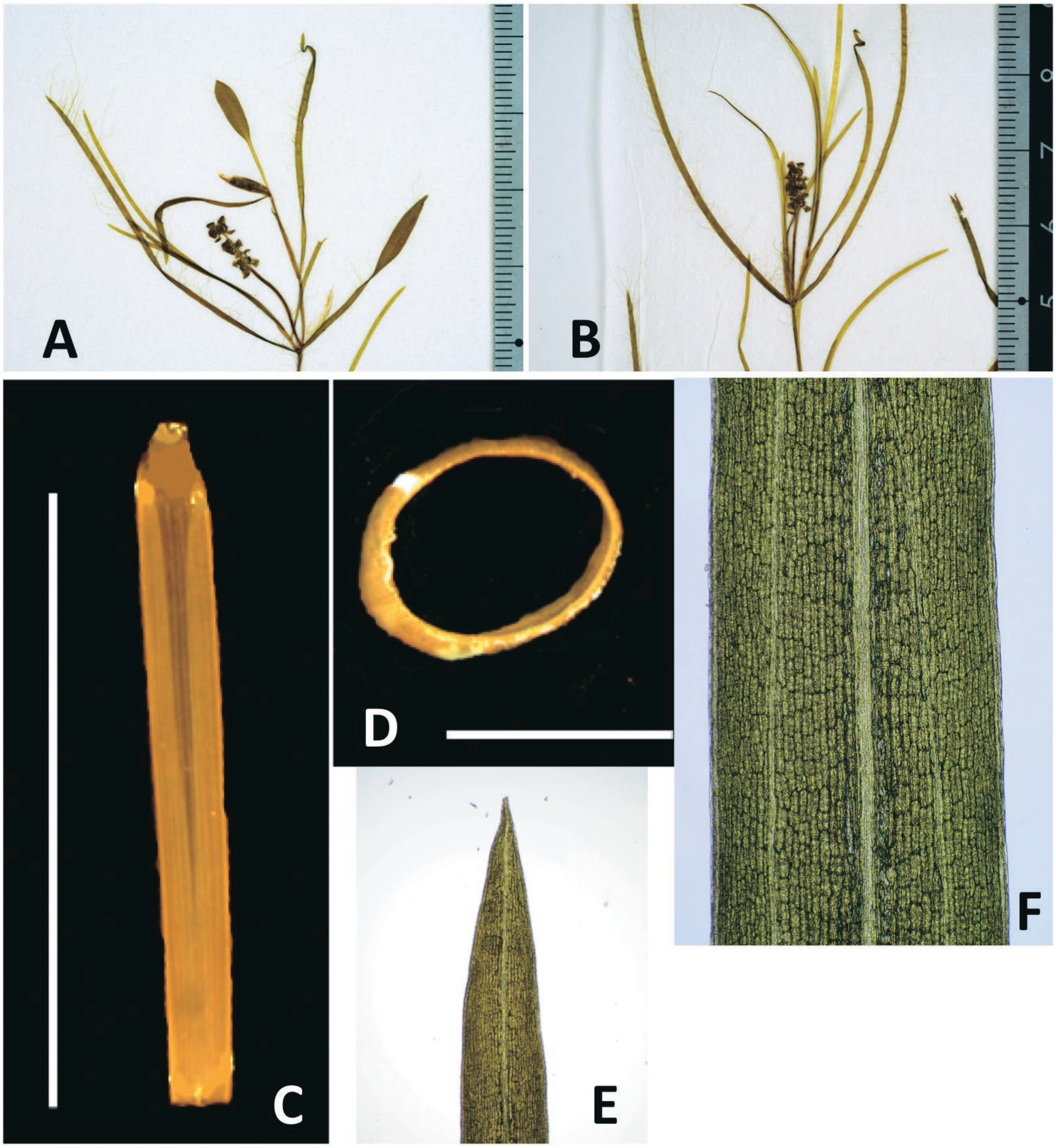


FIG.2. *Potamogeton* ×*tosaensis*. A: Flowering shoot with floating leaves. B: Flowering shoot without floating leaves. C: Stipule connate at base. Scale bar =10 mm. D: Transverse section of stipule. Scale bar =1 mm. E: Acute apex of submerged leaf. F: 3-nerved submerged leaf.

specimens with this morphology in the Maeda River, Kochi City, and assigned them to *Potamogeton* aff. *octandrus*. We studied their specimens and identified them as *P.* ×*tosaensis*.

Taxonomical notes. Miki (1935) described *Potamogeton apertus* Miki as a hybrid between *P. panormitanus* Biv. (Syn. *P. pusillus*) and *P. oxyphyllus* Miq. *Potamogeton apertus* also has connate stipules and resembles *P.* ×*tosaensis*, but its submerged leaves are longer (10 cm), slightly broader (1.5 mm), and 6-nerved. The flowers of *P. apertus* have six pistils; those of *P.* ×*tosaensis* have four pistils.

According to Shiga *et al*. (2009), the specimens of *Potamogeton apertus* in the collection of

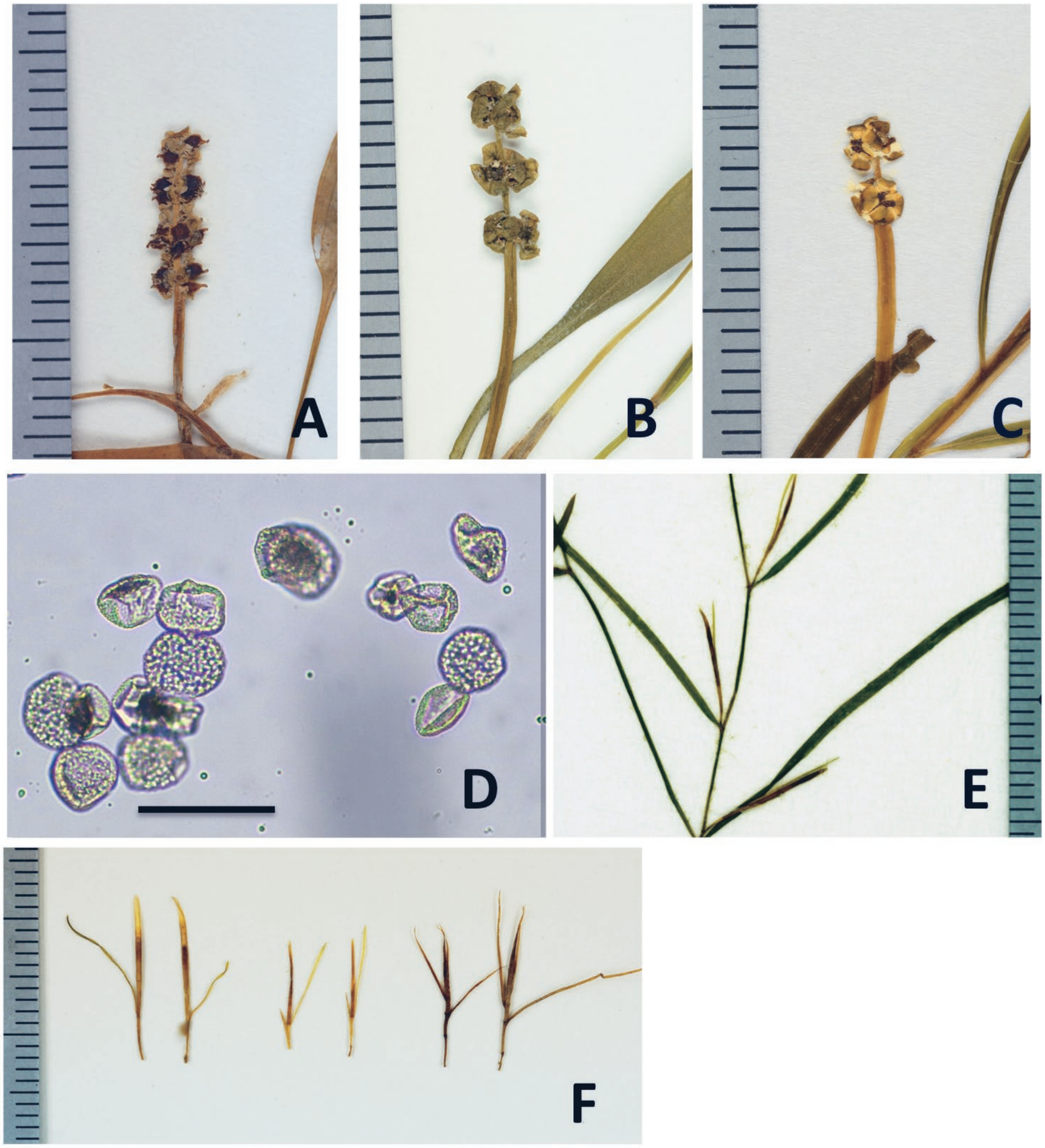


FIG.3. A: Infloresence of *Potamogeton octandrus*, B: Infloresence of *P. ×tosaensis*, C: Infloresence of *P. pusillus*, D: Pollen grains of *P. ×tosaensis.* Scale bar =5µm. E: Axillary turions of *P. ×tosaensis*. F: Comparison of the shape of turions of *P. pusillus* (left), *P. ×tosaensis* (middle) and *P. octandrus* (right).

Dr. Shigeru Miki in the herbarium of Osaka Museum of Natural History (OSA) were covered by a sheet of paper on which the name "*Potamogeton tosaense*" was written. Dr. Miki might have believed those specimens would be described under that name (Shiga *et al*. 2009). Dr. Miki, however, published it under the name of *Potamogeton apertus*: the species epithet '*tosaense*' does not appear in any literature. Here we use the name *P. ×tosaensis* for the hybrid described in this paper.

Wiegleb & Kaplan (1998) assumed *Potamogeton apertus* to be a hybrid between *P. octandrus* and *P. pusillus*. In the herbarium of Kobe University, several specimens were tentatively identified as *P. octandrus* × *P. pusillus* (e.g., Kadono & Wiegleb 1155 from Nagano Pref., and

Wiegleb & Kadono 1159 from Iwate Pref.) by G. Wiegleb. Those specimens have connate stipules, but the plants are completely submergent with no indication of flowering or floating leaf formation. Although the identities of those specimens remain unclear, they differ from *Potamogeton ×tosaensis*.

Potamogeton subjavanicus Hagstr., which was described based on a single specimen from South Africa (Hagströem 1916), is the taxon most similar to *P. ×tosaensis*; both have connate stipules, three-whorled flowers, and are sterile. Wiegleb & Kaplan (1998) treated *P. subjavanicus* as a synonym of *P. pusillus* for unknown reasons. In the African Plant Database at the Conservatoire et Jardin Botaniques Villede Geneve (http:// www. ville-ge.ch/cjb/bd.php), it is also treated as a heterotypic synonym of *P. pusillus*, probably following the opinion of Wiegleb & Kaplan (1998). Without additional information, *Potamogeton ×tosaensis* should not be treated as a synonym of *P. subjavanicus*. The relationship between these two taxa should be subjected to a detailed study.

Identification of specimens. The connate stipules are difficult to confirm in dried specimens. We therefore recommend examining young, fresh material. The following combination of traits enables the identification of specimens as *Potamogeton ×tosaensis*: flowering on shoots with or without floating leaves; spikes 7–12 mm long, usually six flowers per spike; turion axillary, fusiform, 1.0–1.5 cm long, with 1(or 2) acerose leaf.

We thank Prof. S. Ishikawa, Kochi University, for allowing us to study the *Potamogeton* specimens collected from the Kochi area. Dr. T. Shiga, Niigata University, informed us of the use of the name *Potamogeton tosaense* in Dr. Miki's Collection.

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